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PROCESS AND APPARATUS FOR PRODUCING A CONTAINER DEGRADABLE THROUGH COMPOSTING OR DIGESTION AS WELL AS A CONTAINER SUCH AS THIS

[VERFAHREN UND VORRICHTUNG ZUR HERSTELLUNG EINES DURCH VERROTTUNG ODER VERDAUUNG ABBAUBAREN BEHAELTER SOWIE DERGLEICHEN BEHAELTER]

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Description

The invention concerns the production of a container degradable through composting or digestion, in particular a container in the form of a plant container for accommodating live plants and seeds, or a container for storing mineral feed blocks for animals, based on a mixture of animal and/or vegetable fibers, the usual fillers, pigments or active ingredients mixed with soluble glass and hardenable with a reactive component.

Containers or packages for growing decorative or useful plants as well as also for storing feed for farm animals have been produced until now, taking into consideration their sufficient stability, predominantly on the basis of plastics, metals, or cardboard. In particular plant containers, which hold the root ball, are made of a humidity resistant plastic, which should have a sufficient strength over a long period of time in order to hold together the root ball and make possible a constant watering. For planting, the plants are removed from the container; the plastic containers must as a rule be discarded. Since discarding packages of plastic presents increasing difficulties, the ecological acceptance of these packages of plastic is being increasingly lost. This

applies in the same way to the packages for feed for breeding animals. These containers require a constant disposal of packaging materials and presuppose in addition a considerable effort.

Attempts at counteracting this, such as using recycled paper pellets, peat, and other compostable materials, have not achieved sufficient success until now, which is connected in general with the low shelf life and the considerably reduced strength values of compostable plant growing containers in contrast with plastics. Furthermore, it has not been possible to sufficiently define the animal physiological acceptability of the replacement materials known until now, so that a utilization of these containers for packaging feed is for this reason not yet advisable.

In EP 613 905 was described a compostable plant pot based on natural vegetable or animal fibers, which consists of up to 90% of fibers and a bonding agent. Potato pulp pretreated under the action of enzymes is utilized as bonding agent. In EP 613 906 is proposed at the same time a molding based on wood or cellulose fibers in the form of a fiberboard, in which potato pulp is likewise used as bonding agent. In both cases, the moldings, which are held together by means of the adhesive force of the starch, do not have the definable shelf life required when they are

under constant mechanical stress and simultaneous effects of humidity. This is the case in particular when the containers are destined for packaging, transportation, or storage of fluidic animal feed. The disposal of moldings is in addition only planned by means of composting.

It is also known to use different bonding agents during the production of fiberboards from wood materials having different strength properties, which accordingly influence as a rule the duration of the composting in dependence upon the degree of their hardening. The adhesives used during the production of fiberboards from wood are, for example, hardenable synthetic adhesives. In DE 43 16 901 is furthermore described the production of fiberboards in the form of insulating material by using soluble glass as bonding agent, which is caused to harden by applying hot gas by means of carbon dioxide gas. The production of the insulating material requires first a comparatively low compaction of the mixture provided as bulk material, which consists of wood fibers of annual or perennial plants. These fibers form a structure through which the gas flows, in which dot-shaped or small contact areas are formed. For this reason, these moldings are not suitable for the production of liquid-tight containers and the storage of fluidic products. It is known, in addition,

that fiberboards have a tendency to a fast humidity reduction due to the low moisture content of their fibers, which can lead to deformations and rejection of the moldings as a consequence of an irregular adsorption of moisture and likewise does not make possible a long shelf life. In the practice, fiberboards are therefore subjected to a laborious conditioning or protected with a moisture barrier in order to increase their practical value. Particularly durable fiberboards are produced by means of a higher glue portion and a subsequent impregnation. Fiberboards produced in a more complex manner, such as this one, cannot be fed to a compositing or disposed of by means of composting without further treatment.

Due to the listed reasons, the insulating materials described in the description of DE 43 16 901 are suitable at best for composting after further preparation, but are not suited for storage of fluidic materials. Finally, the proposed insulating materials are not at all degradable through digestion. DE 43 16 901 did not propose any suggestions with regard to this subject.

Moldings in the shape of feed pellets degradable through digestion are described in WO 94/19964. These are pellets that are produced using a liquid bonding agent. As bonding agent for a molding degradable by means of

digestion are taken into consideration in particular lignin sulfonates, sugar, and starch, which are atomized or sprayed in the pressed product. Lignin sulfonates obtained during paper production from sulfite waste liquor as well as also starch or sugar are easy to dissolve in water and have been used as bonding agents for a long time. As a consequence, the moldings produced therefrom have a low durability under the effects of humidity, and the moldings cannot be used for packaging mineral feed blocks.

The invention has accordingly as an object a process for the production of a container suitable for digestion or composting, which is degraded by composting when it is designed as plant container for accommodating live plants and seeds or by digestion when it is designed for storage of mineral feed blocks for animals, or which, in other words, is not only compostable, but can also be consumed and digested by farm animals. The object of the invention

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concerns a process for producing a container essentially from a mixture of vegetable or animal fibers and with soluble glass, which has the chemical and physiological properties required for animal or plant feed with sufficient mechanical stability, as well as a strength that can be adjusted for composting over a specific time.

The process for the production of a container, which can be degraded by means of composting or digestion, is characterized in that a kneadable compound processable by means of injection molding and consisting with reference to dry weight parts of a mixture of 25 to 50% of animal and/or vegetable fibers, 10 to 20% of the usual fillers, pigments or active ingredients as well as 50 to 75% of aqueous alkaline silicate solution is produced, which is molded by injection molding using pressure and hardened by applying acid gases or aerosols of organic or inorganic acids or anhydrites under chemical conversion of the alkaline silicate solution, and then conditioned.

The proposed process makes possible the production of containers with defined chemical, physical, animal and vegetable physiological properties, which can be adapted to the corresponding utilization purpose of the container. The production process, which is similar to the plastic injection molding process, creates the possibility of producing containers having sufficient strength for the usual applications like that of the otherwise customary plastic containers by way of comparison. The strength properties of the container produced by injection molding rely less on the cooling of the injection molded compound plasticized under the effects of heat, as in the injection

molding of plastics, but initially rather on the compaction of the molding compound caused by the injection pressure during injection molding, and in addition on a hardening of the moldings through the application of a reactive component formed from an acid gas or an acid aerosol. Both can be adjusted, so that the produced container is liquid-tight. The container is thus suitable even for the storage of mineral feed blocks, which are produced directly in the container according to the casting slip process.

According to a preferred embodiment of the process, it is thus provided that the injection molding is carried out at room temperature. The production of the container is considerably simplified in this way with respect to a container made of plastic, because the heating and cooling of the molding compound can be omitted.

The creation of the corresponding strength of the container relies above all on the fact that the alkaline silicate solution encased in the molding compound is hardened by applying acid gas or acid aerosol and converted into amorphous silicon dioxide. The reaction between the alkaline silicate solution and the acid reaction component is of particular importance for the production of the stability of the container. The pressurization of the moldings is suitably carried out already in the mold tool.

Pursuant to another embodiment of the invention, it is accordingly provided that the precipitation of the alkaline silicate solution is carried out with the mold gap open. After a relatively short pressurization time of approx. 10 seconds, the mold gap can then be completely opened and the molding can be removed from the mold tool. The hardening process can be accelerated or the strength can be increased by heating the gases or aerosols used for the hardening. The highest strengths are achieved within the temperature range of 10 to 150°C. The heating of the gases should as a consequence be within a temperature range that does not exceed a temperature of 150°C and amounts to at least 15°C.

Within the scope of the invention, it is furthermore provided that the moldings removed from the injection molding machine are then subjected to a conditioning through storage on a drying shelf at room temperature and repeated air convection over a time period of 12 hours. in this way, the container is equipped with a final strength that is similar to the strength of comparable plastic containers and is configured for a corresponding use.

Suitable water-soluble alkaline silicates, which can be used with the invention, are, for example, sodium silicate or potassium silicate, whose aqueous solutions are usually called soluble glass. The soluble glass reacts

with the acid gases or aerosols under precipitation of silicic acid. During the precipitation, the molecules are spontaneously joined to high molecular chains and rings, so that the silicic acids are unsystematically built, which means that they are amorphous. In this way, they do not generate any silicosis in contrast with the naturally occurring crystalline modifications of silicon oxide, such as quartz. Amorphous silicic acids do not cause any morphological changes of the breathing organs, as is known as a result of experimental long-term analyses. In this way, all of the amorphous silicic acids are considered nontoxic. In addition, the physiological effect of amorphous silicic acids, which among other things have a bloating-reducing and detoxifying effect, is known from veterinary medicine.

The process can be varied in a suitable manner within a particularly broad scope with regard to the application purpose of the container in dependence upon the type of soluble glass and the acid reaction component used for the precipitation. The soluble glass or the acid gases and the used fibers as well as the fillers are suitably selected in such a way that the compostability or the digestibility of the containers is ensured.

It is accordingly advantageous within the scope of the invention to use acid gases, preferably in the form of CO_2 or NO_x or HCl, in order to harden the moldings. This is particularly advantageous when a container suitable for growing plants is to be produced. In this case, animal fibers, in particular animal hair, or fibers, shavings, and granulates of renewable raw materials, in particular wood and annual plants, are suitably used as carrier materials. For the hardening is used potassium silicate, which is precipitated into finely distributed amorphous silicic acid by means of a pressurization with acid gas, such as carbon dioxide. In this way is obtained the advantage that the potassium portion of the soluble glass is made available to the plants through the chemical precipitation. A further advantage is obtained from the loosening and aerating effect of the carrier matrix of the container and the increase of the pH value of the soil due to the composting

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of the container in the soil. As a consequence of its strength, it offers protection to the root ball over a long period of time. The stability of the container can be adjusted in such a way that an undisturbed continued growth or propagation of the root system is possible up to the corresponding time point.

Instead of using acid gases, it is also provided within the scope of the invention to use aerosols of nitric acid, sulfuric acid, phosphoric acid, formic acid, acetic acid, propionic acid, or aerosols from anhydrides for the hardening.

A preferred aerosol is based on a calcium chloride solution. This is particularly advantageous when the provided containers destined for digestion are produced using an animal physiologically advantageous mixture of vegetable fibers, annual plants, and nutrients, as well as sodium silicate. The hardening is carried out by means of pressurization with an aerosol of a calcium chloride solution. As a consequence of the pressurization of sodium silicate is formed amorphous silicic acid, which has a germ inhibiting effect and prevents infections of the digestive tract in animals. From this results the advantage that these containers can be used according to their actual application purpose as package for feeding farm animals. The salts encased in the container help cover the sodium requirement in the breeding of farm animals. If the container is not accepted by the animal, it can be disposed of without problems by means of composting.

In a practical embodiment of the invention, it is further provided that the apparatus for the production of

the container consists of an injection molding machine, which has an injection mold for injection molding with at least one fixed and one movable mold half, wherein the molding compound can be fed via a filling funnel of the injection molding machine and through a plasticizing unit of an injection nozzle arranged opposite to the injection mold. During the production of the container can be made use of an injection molding device, as a consequence, which makes possible a production of the containers predominantly in series, which is therefore relatively inexpensive.

It is provided, in addition, that the plasticizing unit of the known injection molding machine can be operated at room temperature without heating. In this way, the design of the apparatus and the process sequence, which is overall advantageous for the economic production of the containers, are simplified.

In order to improve the filling of the injection mold, the injection nozzle is provided with a modifiable diameter, which is adapted to the molding compound. The latter is designed considerably larger than the injection nozzle for processing thermoplastics. This implies at the same time a faster cycle time during filling of the injection mold and a more economic mode of operation of the injection molding machine.

A container for storing plants and growing seeds is injection molded and has the shape of a plant container. However, the invention is not limited to this embodiment. Other embodiments are conceivable within the scope of the invention.

A container for storing fluidic feed for animals is injection molded and has a round, oval or rectangular base with lateral walls opening at the top, wherein the lateral walls are provided if necessary with handling attachments. These can have, for example, the shape of recessed grips, whereby the handling of the containers is considerably facilitated.

It is finally provided that the container to be filled with fluidic feed is liquid-tight at least for the time of the filling with molassed animal feed, which then solidifies forming an animal feed block. In this way, the container is available for a wide spectrum of applications and can be used for the most different application cases.

The invention will be described in more detail in the following on the basis of two exemplary embodiments.

Exemplar Embodiment 1

10 kg of wood fibers with a particle length of 1-10 mm and a humidity proportion of 12% are intensively mixed for at least 15 minutes in a horizontal mixer with 1 kg of

dolomite flour and 70 g of magnesium oxide. The mixture resulting from this is spray-coated with 15 g of potassium silicate and thoroughly mixed, forming a pasty molding compound. Soluble glass known under the name potassium silicate 28/30 is used.

The molding compound is immediately fed manually into the filling funnel of an injection molding machine. From there, the molding compound arrives in the plasticizing cylinder of the injection molding machine, in which the molding compound is additionally homogenized with the aid of the plasticizing screw rotating within the cylinder chamber. The injection molding of the molding is carried out by means of the pressure that is built up inside the plasticizing cylinder, with which the molding compound is pressed through the modifying injection nozzle into the molding chamber, which is enclosed by the two mold halves of the injection mold. The molding chamber is likewise provided with a degassing gap for the purpose of a better degassing. The gassing of the molding with carbon dioxide gas preheated to 80°C is carried out after the pressure in the injection mold has been relieved and the silicic acid has precipitated in the form of amorphous silicon dioxide. This is carried out according to the formula

$$K_2SiO_3 + CO_2 = K_2CO_3 + SiO_2.$$

The container produced from the molding is then removed from the injection mold and is stored for conditioning on a drying shelf at room temperature for 12 hours. The finished container can be used thereafter for packaging or growing plants. The potassium formed in the composition of the potassium carbonate by means of the precipitation of the silicic acid represents an important nutrient element, which is easy to reabsorb due to its solubility in water. In this way, the container makes available particularly easily the starting fertilizer required for growing plants, aside from the added fertilizer components.

Exemplary Embodiment 2

10 kg of chaffed Linum usitatissimum stems are intensively mixed with 0.5 kg of molassed mineral feed for dairy cattle, forming a homogeneous compound in the horizontal mixer in the same way as in example 1. The

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mixture obtained therefrom is spray-coated with 12 kg of commercially available potassium silicate and mixed until an injection moldable compound has been obtained.

Soluble glass with the trade name potassium silicate 37/40 is used in this exemplary embodiment.

The finished molding compound is immediately filled into a filling funnel of an injection molding machine and injection molded. The gassing of the moldings is carried out after the mold gap has been opened, in this case with HCl gas. The precipitation of the silicic acid is carried out according to the equation

$Na_2SiO_3 + 2HCl = 2\ NaCl + SiO_2 + H_2O$.

After a time of approx. 10 seconds, the container can be removed from the injection mold. The container, which has, for example, the shape of a bucket with recessed grips, is stored for further hardening and drying on a drying shelf at room temperature and repeated air convection. After at the most 12 hours, the fully conditioned container can be filled with a liquid mineral food compound by the mineral feed producer. Even though the invention has been described in connection with preferred exemplary embodiments, it is not intended therewith to limit the invention to the described exemplary embodiments. The invention comprises rather also all the modifications and equivalent embodiments, insofar as they are within the scope of the claims.

Patent Claims

1. A process for producing a container degradable through composting or digestion, in particular a container in the form of a plant container for accommodating live plants and seeds, or for storing mineral feed blocks for animals, based on a mixture of animal and/or vegetable fibers, the usual fillers, pigments or active ingredients mixed with alkaline silicate solution and hardenable with a reactive component, characterized in that a kneadable compound processable by means of injection molding and consisting with reference to dry weight parts of a mixture of 25 to 50% of animal and/or vegetable fibers, 10 to 20% of the usual fillers, pigments or active ingredients as well as 50 to 75% of aqueous alkaline silicate solution, is produced, which is molded by means of injection molding using pressure, and hardened by applying acid gases or aerosols of organic or inorganic acids or anhydrites under chemical conversion of the alkaline silicate solution, and then conditioned.

2. The process for producing the container degradable through composting or digestion of claim 1, characterized in that acid gases in the form of CO_2, NO_x, or HCl are used for the hardening.

3. The process for producing the container degradable through composting or digestion of claim 1, characterized in that acid aerosols of nitric acid, sulfuric acid, phosphoric acid, formic acid, acetic acid, propionic acid, or aerosols of anhydrite solution are used for the hardening.

4. The process for producing the container degradable through composting or digestion of claim 1, characterized in that an aerosol based on a calcium chloride solution is used for the hardening.

5. The process for producing the container degradable through composting or digestion of one or several of the claims 1 to 4, characterized in that heated gases or aerosols within a temperature range that does not exceed a temperature of 150°C and amounts to at least 15°C are used for the hardening.

6. The process for producing the container degradable through composting or digestion of one or several of the claims 1 to 5, characterized in that the subsequent conditioning is carried out through storage on a drying shelf at room temperature and repeated air convection at room temperature over a time period of 12 hours.

7. The process for producing the container degradable through composting or digestion of one or several of the

claims 1 to 6, characterized in that a container destined for digestion is produced using an animal physiologically harmless mixture of vegetable fibers from annual plants and nutrients as well as sodium silicate, which is hardened by means of a calcium chloride solution.

8. The process for producing the container degradable through composting or digestion of one or several of the claims 1 to 7, characterized in that a vegetable physiologically valuable mixture consisting in particular of animal fibers, wood or bark particles, textile fibers, paper granulate or other granulates and potassium silicate is produced and hardened preferably with carbon dioxide gas.

9. The process for producing the container degradable through composting or digestion of one or several of the claims 1 to 8, characterized in that the gassing of the molding is carried out within the injection mold and with the mold gap open.

10. An apparatus for the production of a container degradable through composting or digestion of one or several of the claims 1 to 9, characterized in that said apparatus consists of an injection molding machine, which has one fixed and one movable mold half, into which the molding compound can be fed via a plasticizing unit and an injection nozzle.

11. The apparatus for the production of a container degradable through composting or digestion of one or several of the claims 1 to 10, characterized in that the plasticizing unit is operated at room temperature and without heat.

12. An apparatus for the production of a container degradable through composting or digestion of one or

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several of the claims 1 to 11, characterized in that the injection nozzle has a modified diameter.

13. A container according to one or several of the claims 1 to 12, characterized in that said container is injection molded and has a round, oval or rectangular base with lateral walls opening at the top, which are provided if necessary with handling attachments and can be configured, for example, in the shape of recessed grips.

14. The container according to one or several of the claims 1 to 13 for accommodating live plants and seeds, characterized in that said container has the shape of a plant container.

15. The container according to one or several of the claims 1 to 14 for the storage of mineral feed blocks for animals, characterized in that the latter has a liquid-tight configuration at least for the period of filling with

molassed animal feed, which then solidifies to a mineral feed block.